New and Alternative Forages for Modern Dairy Rations in the Northeast

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Some Challenges for Our Dairy Forage Systems

Can Perennial Forages Meet Dairy Quality Needs?

Depends on consistent forage:

- Quality (NDF level)
- Digestibility (NDFD)
- Particle size
- Rate of passage
- Palatability
- Inventory (how much is available)

Larry Chase, 2012

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Using NDF for targeting when to harvest your haycrop?

• Legume	40%
• Grass	50%
• Mixture	varies
- MML	42 - 44%
- MMG	46- 48%

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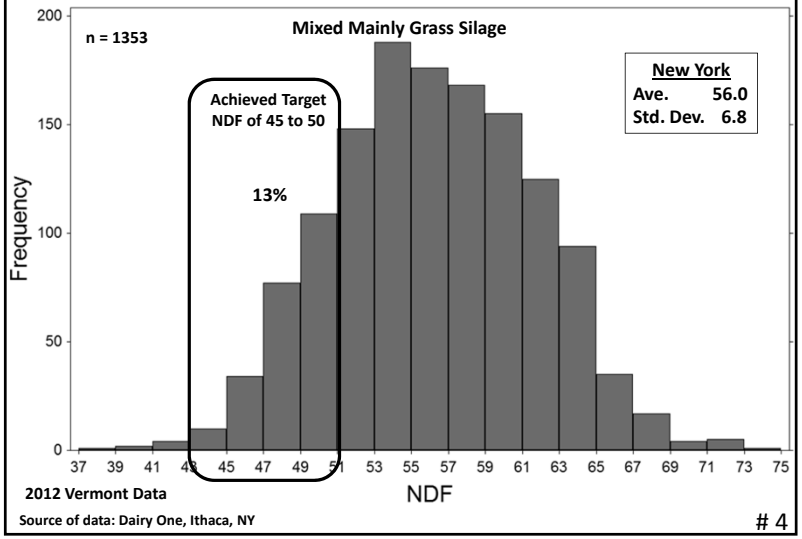
Are We Meeting Our Target NDF?



Source of data: Dairy One, Ithaca, NY

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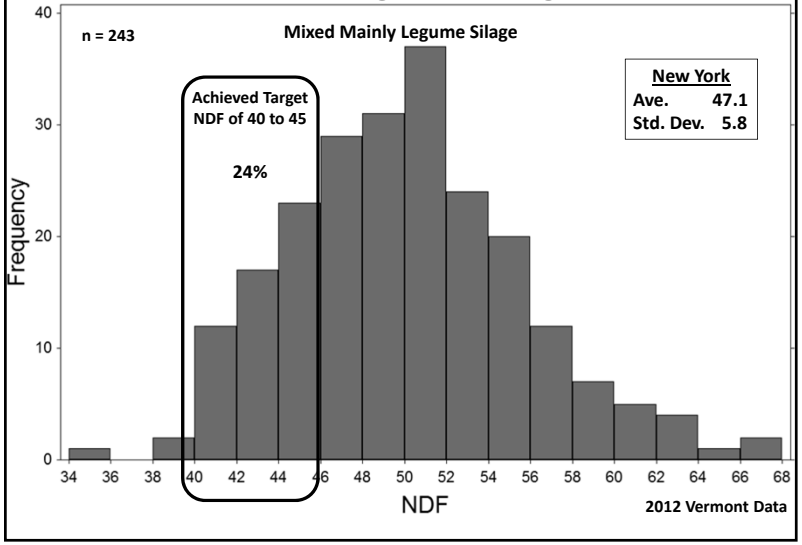
Are We Meeting Our Target NDF?



Forage quality data from New York Farms analyzed at the Dairy One Lab (Dec/Feb)

					Normal Range*	
Type	Year	Item	n	Average	Low	High
Mixed Mainly Grass Silage	2012	CP	524	17.1	13.7	20.5
		NDF	641	56.0	49.3	62.8
		$NDFD_{30}$	259	58.1	52.0	64.3
	2014	CP	573	17.2	13.7	20.8
		NDF	562	54.5	48.2	60.8
		$NDFD_{30}$	244	58.5	52.4	64.5
	2015	CP	662	17.4	14.2	20.5
		NDF	507	53.8	48.2	59.3
		$NDFD_{30}$	201	60.0	53.4	66.5
Mixed Mainly Legume Silage	2012	CP	244	20.6	17.4	23.8
		NDF	244	47.1	41.3	52.8
		$NDFD_{30}$	89	54.8	48.7	60.8
	2014	CP	328	20.8	18.1	23.6
		NDF	323	47.7	42.7	52.8
		$NDFD_{30}$	139	56.0	50.6	61.4
	2015	CP	334	20.6	17.8	23.3
		NDF	219	48.1	42.3	53.8
		$NDFD_{30}$	94	56.6	50.6	62.7

*Within one standard deviation

Controlling Forage Quality **Consistently**?

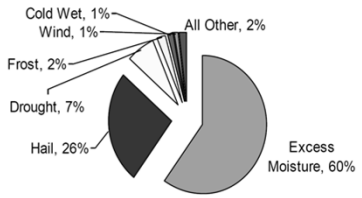
Some Challenges for Our Dairy Forage Systems

What's Happening With Our Weather?

- Prolonged rainy periods
- Too many "100 year" floods
- Extended dry periods
- Increasing temperatures

Why Vermont Crops Fail (2001-10)

Since 1988, Crop Ins. provided
$213 Bil. of Protection and Paid $15 Million
in Loss Payments to VT Farmers



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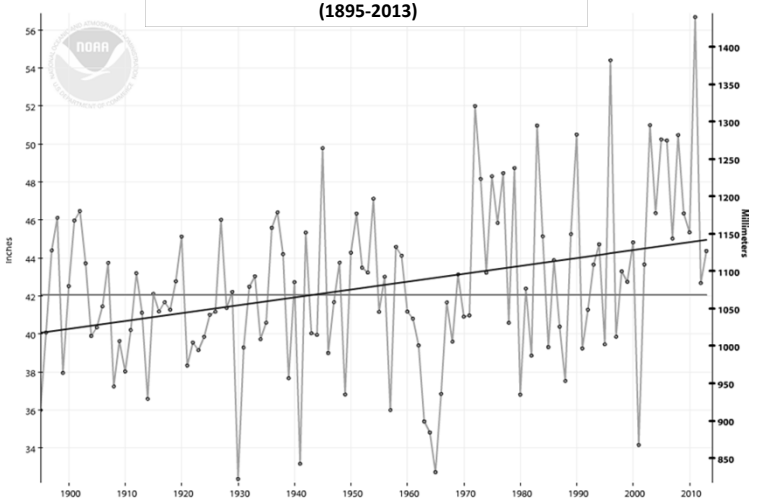
Northeast Annual Precip.: +4.15"/century (1895-2013)



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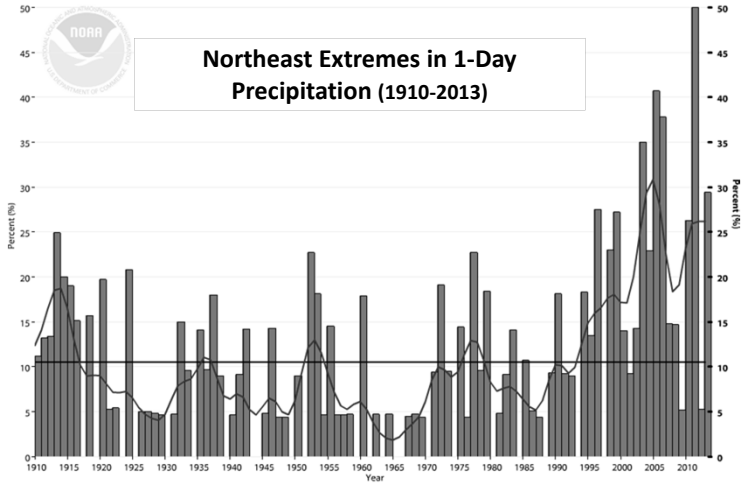
Northeast Extremes in 1-Day Precipitation (Step 4*)
Annual (January-December) 1910-2013

9-Point Binomial Filter — Mean — Actual Percent

Northeast Extremes in 1-Day Precipitation (1910-2013)



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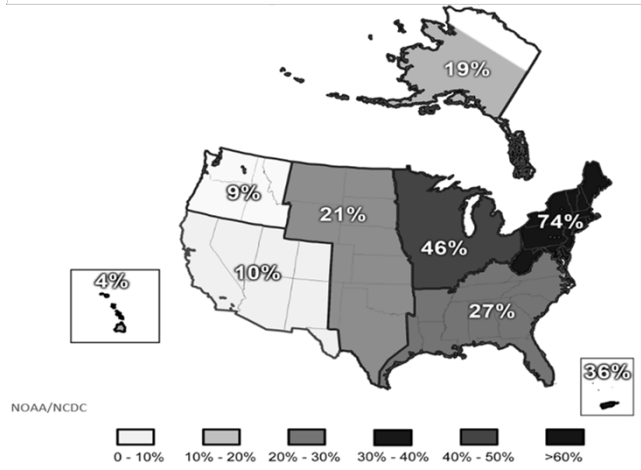
Trend in 1-day Very Heavy Precipitation (1958-2010)



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Weather Extremes and Forages

Prolonged rainy periods

- Delayed harvest
- Plant stress
- Reduced protein
  - Soil N losses
  - Poor N fixation
- Reduced energy
  - Low sugar content

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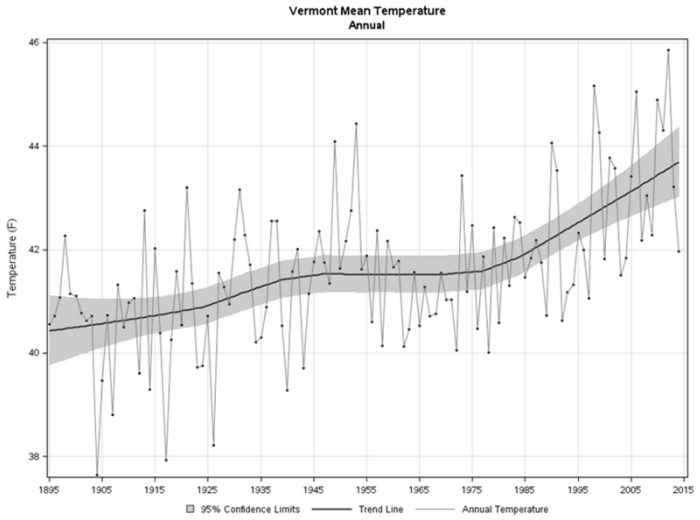
Temperature and Forage Quality



*NOAA National Climatic Data Center

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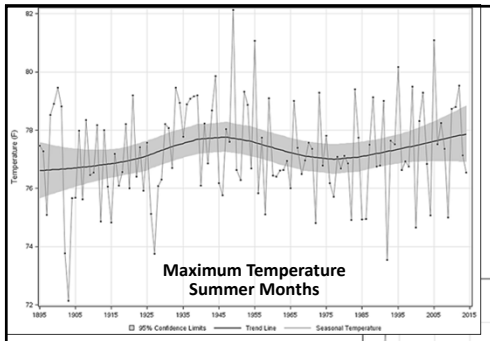
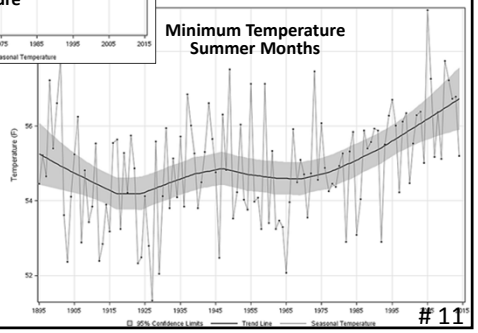


Change In New York Summer Temperature



What's the impact on forage quality?

*NOAA National Climatic Data Center

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Elevated Temperature and Forage Quality

- Earlier reproductive development
- Plant stress
- Lignification
  - Lower NDFD
- Reduced energy
  - Low sugar content

What Can Farmers Do To Control in Their Forage Program?

- Species/variety selection
- Soil management
- Fertility and liming
- Pest and weed management
- Cutting/grazing practices
- Storage
- Feeding

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Species And Cultivar Selection

- **Yield**
- **Quality**
  - **Crude protein**
  - **Digestibility**
  - **Tolerance of frequent harvests**
  - **Leaf texture***
- **Maturity (early to late)**
- **Disease resistance**
- **Winter hardiness**
- **Persistence (short term vs. long term rotation)**
- **Endophyte enhanced**

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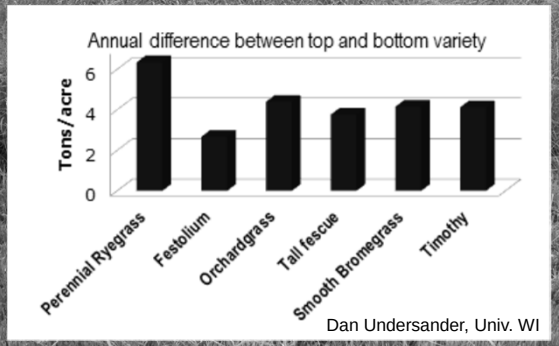
Selecting Grasses for Yield

- Grass species vary in yield but varietal differences can be larger than species



Dan Undersander, Univ. WI

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Selecting Grasses for Quality

- Want grasses that tolerate intensive cutting

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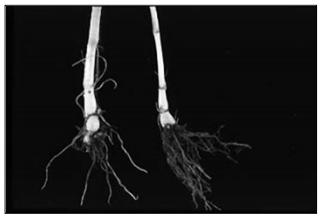
What About Timothy?



- Tolerates wet sites
- Winter hardy
- Easy to establish

But…

- Does not tolerate early, frequent cuts
- Low summer yield
- Lower in CP than other CSGs

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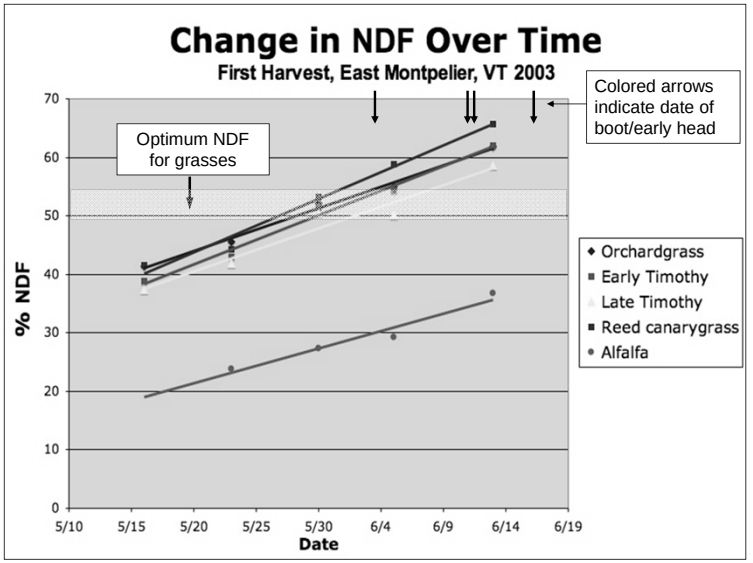

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Proportion of Reproductive Tillers

Timothy

Almost 100%

Orchardgrass

Varies but less than 100%

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Staging Grasses

Vegetative Elongating Boot Heading

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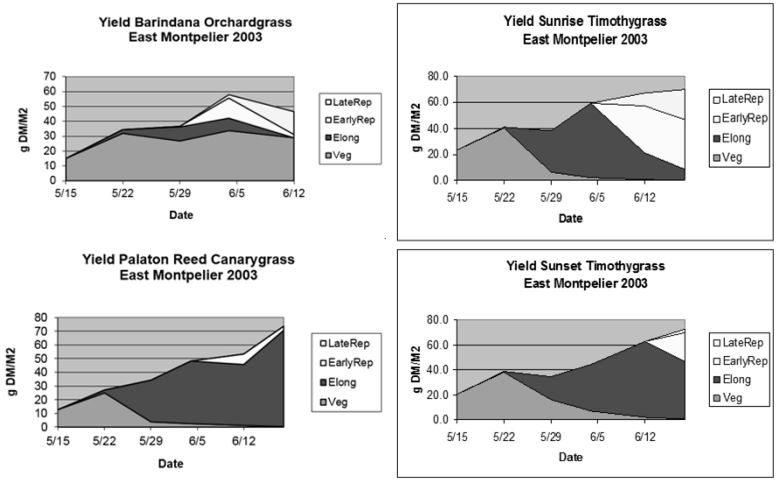
Tiller Stages of Grass Treatments



How does this affect forage quality of these grasses?

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Tall Fescue as part of a haylage mixture for NY and VT

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Tall Fescue as part of a haylage mixture for NY and VT

Cornell University Plant Breeding grass trials at Ithaca, NY.
Four harvests per season with 200 lbs N/acre applied.

Grass	Years	Tons DM/acre
Tall Fescue	2006-10	6.7
Orchardgrass	2006-10	5.7
Smooth bromegrass	2008-10	5.5
Timothy	2006-10	5.4
Reed canarygrass	2006	5.3
Perennial ryegrass	2006-10	4.4

Source: Cherney, Cornell

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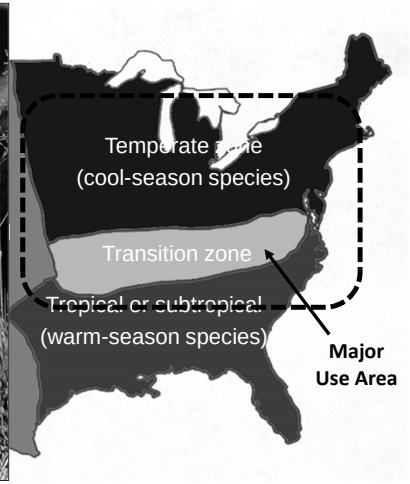
Fescue Adaptation

Tall fescue is more tolerant to heat than other cool season grasses, yet, quite winter hardy

Better summer yields compared to other cool season grasses



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Grass Demonstration Trials in NE Vermont

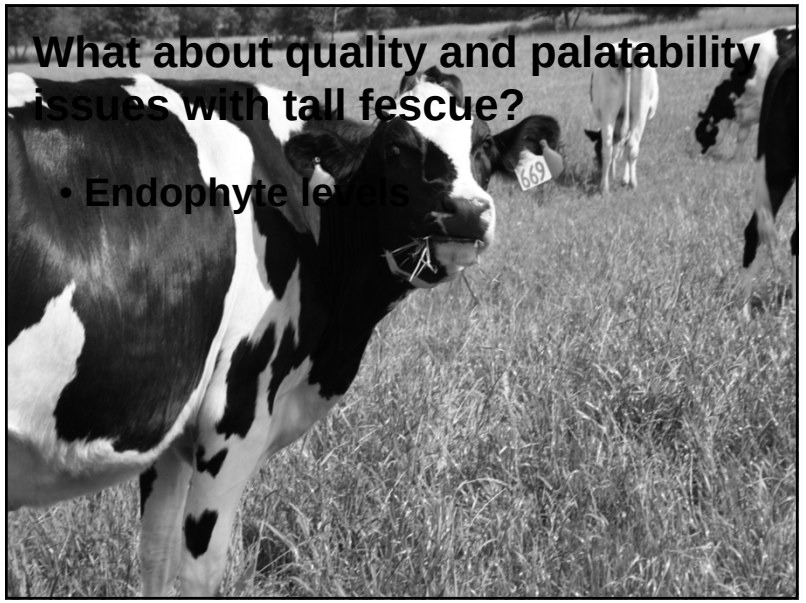
Enhance Tall Fescue

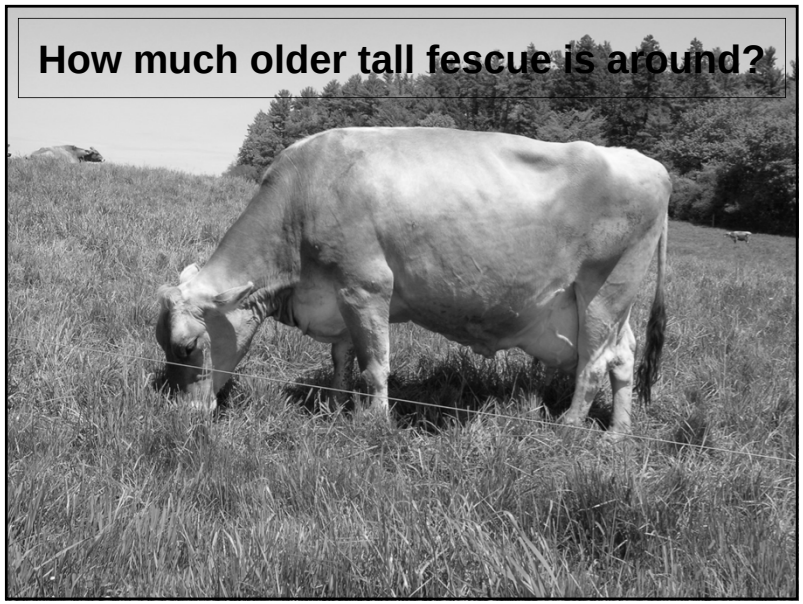
Cutting	Tons/ac	CP	ADF	NDF	48h NDFd	NEL	NFC
1	1.3	15.6	27.9	48.8	63.2	0.68	29.1
2	0.8	14.3	31.5	51.4	79.0	0.74	25.2
3	0.6	14.7	33.6	54.0	76.4	0.71	21.3
4	1.0	16.3	34.4	56.1	73.0	0.68	17
5	0.4	14.2	31.4	51.9	77.0	0.72	23.8
	4.1						

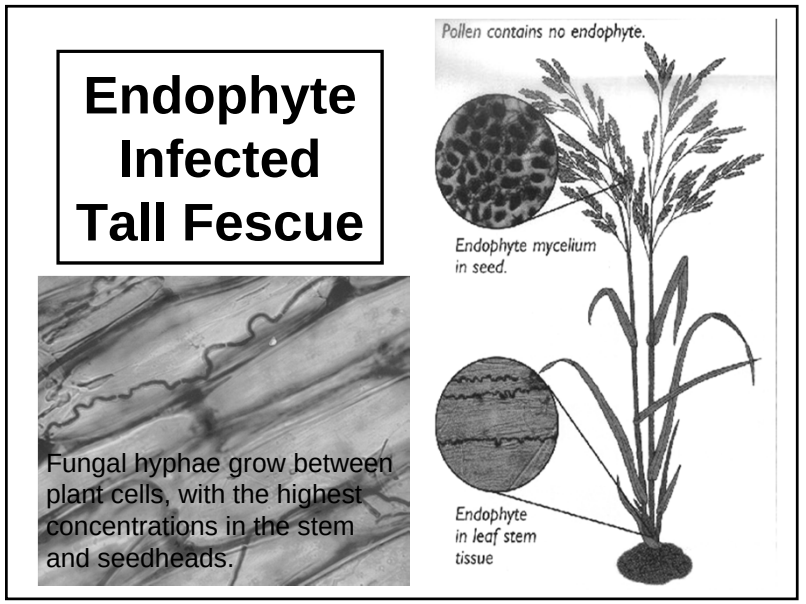
Enhance Tall Fescue + Red Clover

Cutting	Tons/ac	CP	ADF	NDF	48h NDFd	NEL	NFC
1	1.6	20.6	27.8	45.4	64.6	0.69	27.7
2	1.0	19.9	30.1	46.2	66.2	0.68	25.0
3	1.0	18.5	34.2	50.8	67.1	0.67	21.3
4	1.2	19.1	36.5	55.2	63.5	0.63	15.8
5	0.9	19.1	28.8	44.0	74.7	0.72	25.9
	5.7						

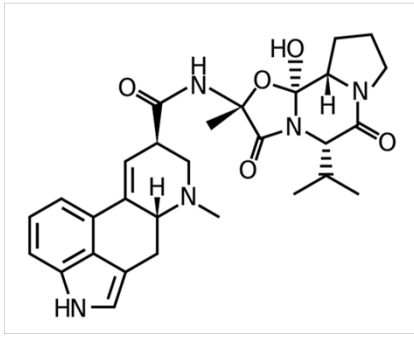
Source: Dan Hudson, UVM Extension



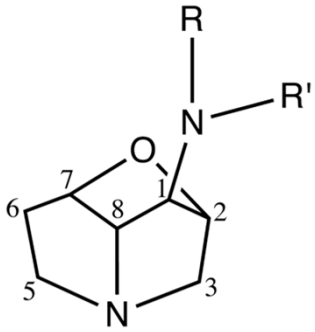




Tall Fescue Alkaloids



Ergovaline



Loline

One of the Ergot Alkaloids

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Testing for endophyte

- ELISA test
- Randomly collect 60 to 100 fresh tillers
- Cut out and save the lower portion (crown and lower three inches of the tiller)
- Keep cool and fresh

Stem cross sections are placed in ELISA cells for detection

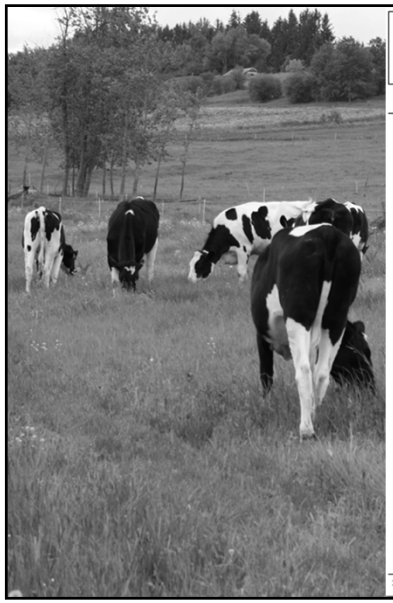
Northeast study conducted by USDA-ARS

Abundance in the Northeast: Tall fescue was found on 89% of the farms sampled and 84% of the pastures. Its average cover was 17.3% where present (range 0.1 - 89.9%).

Pasture Plants of the Northeastern United States 2014
Sarah Goslee, USDA-ARS Pasture Systems and Watershed Management Research Unit, Bldg. 3702 Curtin Rd., University Park, PA 16802

Small Plot Site, Randolph, VT
18 Commercial Mixtures
5 Festulolium cultivars with white clover
4 Orchardgrass cultivars with white clover
1 Alaska bromegrass with white clover

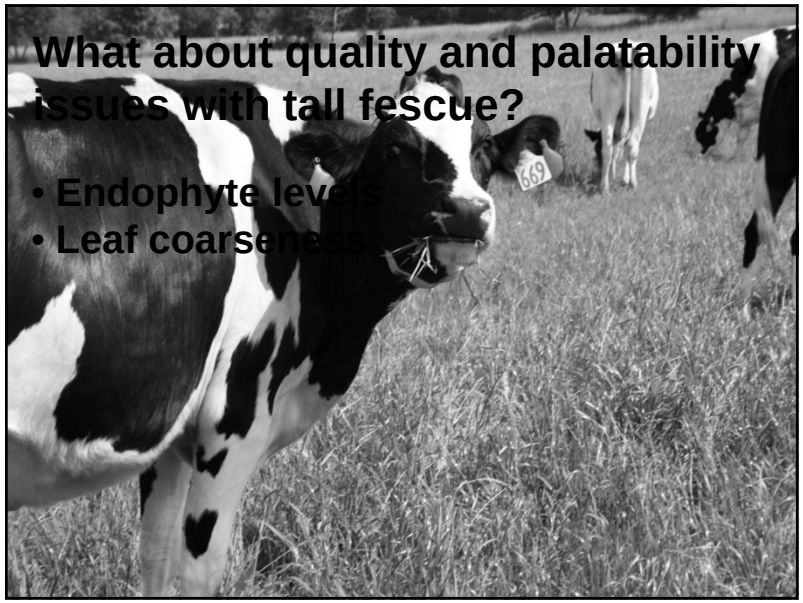
Three replications



Visual Grazing Score on 6/29/2010 of 18 commercial and four orchardgrass/white clover pasture mixtures in Randolph, VT (3 replications seeded 8/07)

Mixture Number	Grazing Score[1]	% Tall Fescue	
9	6.7	0.0	
19	6.3	0.0	
21	6.0	0.0	
11	5.3	0.0	
22	5.3	0.0	
7	5.0	0.0	
15	5.0	0.0	
3	4.7	0.0	
4	4.7	0.0	
5	4.7	0.0	
18	4.7	0.0	
20	4.7	0.0	
23	4.7	0.0	
16	4.3	0.0	
1	4.0	0.0	
8	4.0	1.6	←
12	4.0	18.7	←
17	4.0	0.0	
2	3.7	24.0	←
10	3.7	22.2	←
6	3.3	0.0	
14	2.7	19.2	←
13	1.7	39.6	←

[1]Grazing Score: 1 - untouched to 10 - uniformly grazed down



What about quality and palatability issues with tall fescue?

- Endophyte levels
- Leaf coarseness

Tall Fescue Leaves Can Be Very Coarse

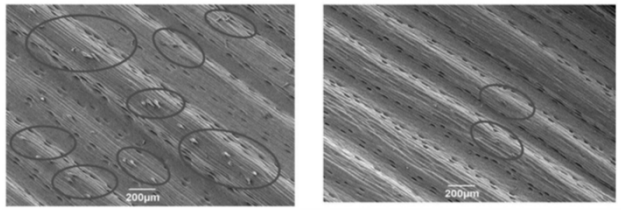
Soft-Leaved Tall Fescue

Soft-leaved tall fescue

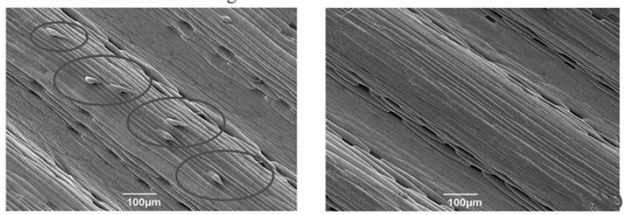
Traditional Rough leaf tall fescue

"Harsh" variety "Soft" variety

A Abaxail surface x60 mag



B Abaxail surface x150 mag

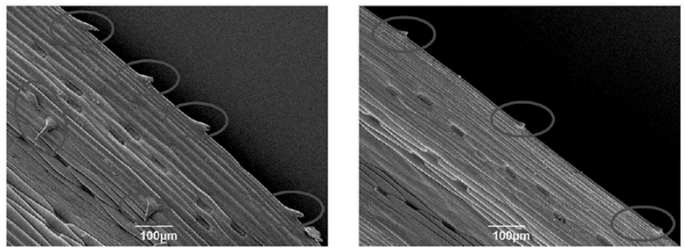


Red circles indicate leaf spine presence

Hartley et.al., 2015. **FrontiersinPlantScience: Vol. 6, Art. 35 (Un. of York, UK)**

"Harsh" variety "Soft" variety

C Abaxail leaf margin x150 mag

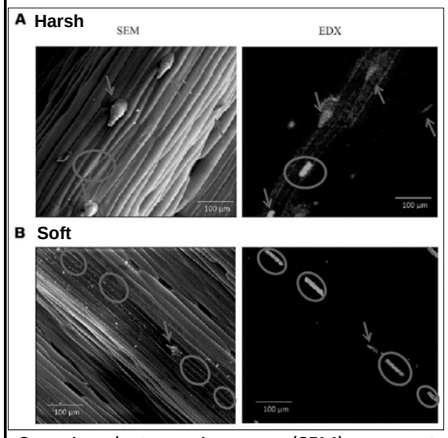


Red circles indicate leaf spine presence

"The spines present on the harsh variety were bigger in size and the point of the spines were spear-like in appearance; these spines also appeared to protrude more from the surface compared with the soft variety, where the spines were smaller in size and the points of the spines lay closer to the surface of the leaf."

Hartley et.al., 2015. **FrontiersinPlantScience: Vol. 6, Art. 35 (Un. of York, UK)**

Harsh Verses Soft-Leaved Tall Fescue



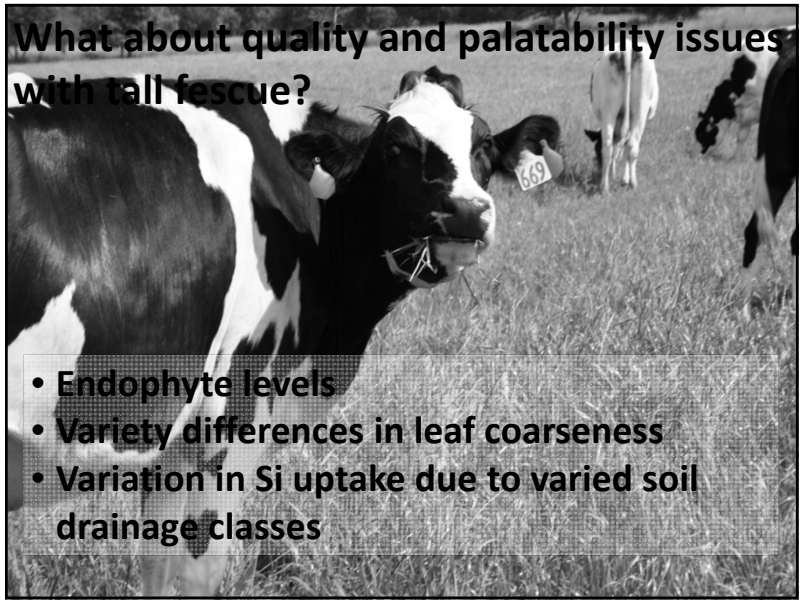
The spines were rich in Si and there were other Si deposits on the leaf surface in the form of silica short cells.

Generally, the harsh variety (A) had a greater over surface deposition of Si compared with the soft one.

The soft variety (B) deposited Si as silica short cells on the leaf surface within fewer, smaller leaf spines containing less Si than in the harsh variety.

Scanning electron microscope (SEM) represented by grey images. Electron density X-ray spectroscopy (EDX) represented by black and green images; green intensity indicates Si concentration. Red circles indicate trichomes with Si deposition. Red arrows indicate silica short cells.

Hartley et.al., 2015. **FrontiersinPlantScience: Vol. 6, Art. 35 (Un. of York, UK)**



RANGELAND PLANT ECOLOGY WORKING GROUP

Grazing Preference of Tall Fescue as Affected by Leaf Softness and Endophyte Infection

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Tim D. Phillips, University of Kentucky, Lexington
Andy Hopkins
Mike Trammel, Noble Foundation, Ardmore, OK

RANGELAND PLANT ECOLOGY WORKING GROUP

Conclusions

Grazing Preference of Tall Fescue - Leaf Softness and Endophyte Infection

1. Leaf softness did not affect grazing preference.
2. Endophyte infection might affect grazing preference when biotic/abiotic stress causes plant death.
3. Overall, there is very little variation in tall fescue for grazing preference.
4. Therefore, tall fescue breeding programs should focus on forage yield and nutritional quality.

Meadow Fescue

- A cold climate grass originally from northern Europe
- Introduced in the U.S. and Canada in the early 1800's
- Lost out in popularity in the mid 1900's – more or less forgotten
- Rediscovered in 1990's by Wisconsin dairy grazing farmer in the Driftless region of southwestern Wisconsin

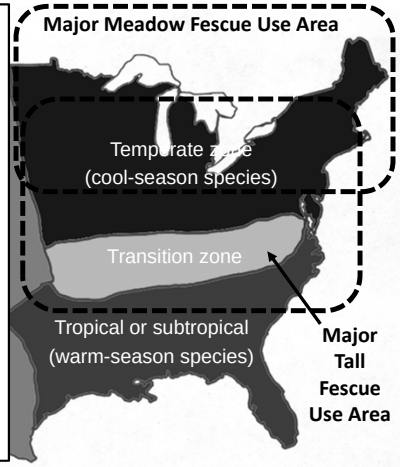
The Fescues

Tall Fescue **Meadow Fescue**

Fescue Adaptation

Meadow fescue is a cold climate grass.

Tall fescue is more tolerant to heat than other cool season grasses, yet, quite winter hardy



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Meadow Fescue Quality

NDF digestiblity at each cut of five cultivars (means of two residual sward heights, two locations and two years)

Cultivar	Cutting		
	1	2	3
	- % of NDF -		
Azov Meadow Fescue	65.3	66.2	65.9
Bartura Meadow Fescue	65.7	66.0	68.6
Hidden Valley Meadow Fescue	68.4	67.7	70.0
Barolex Tall Fescue	61.4	59.0	64.2
Bronc Orchardgrass	59.8	60.4	61.3
LSD (0.05)	1.2	0.8	1.0

Source: Brink, Casler and Martin. 2010. Agronomy J. 102: 667-674

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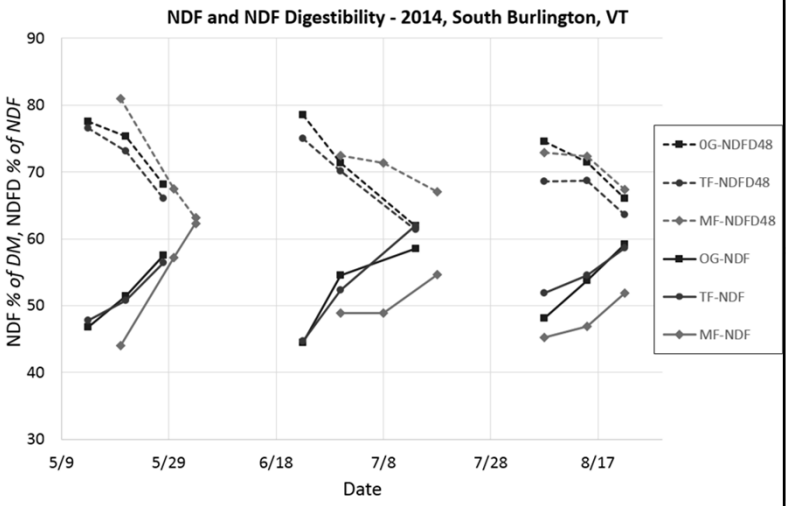
Orchardgrass, Tall Fescue and Meadow Fescue Quality



Source: Bosworth and Darby, Un. of Vermont

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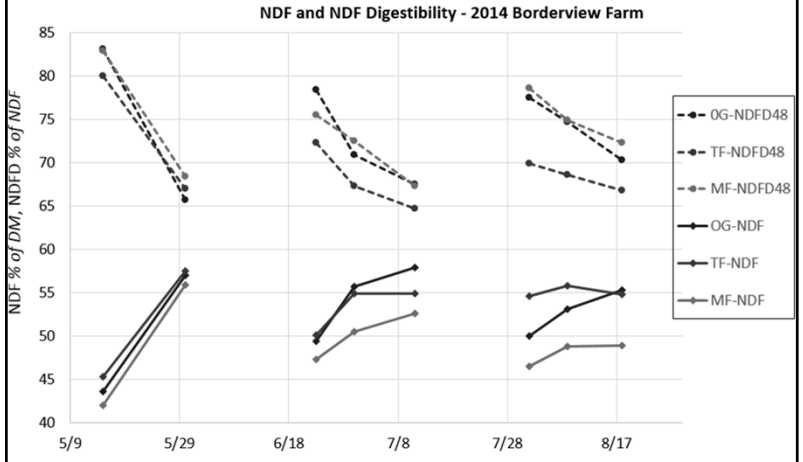
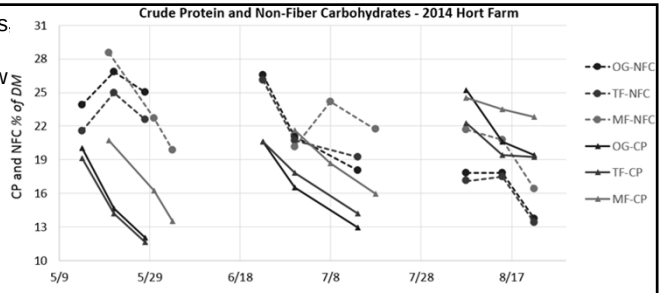
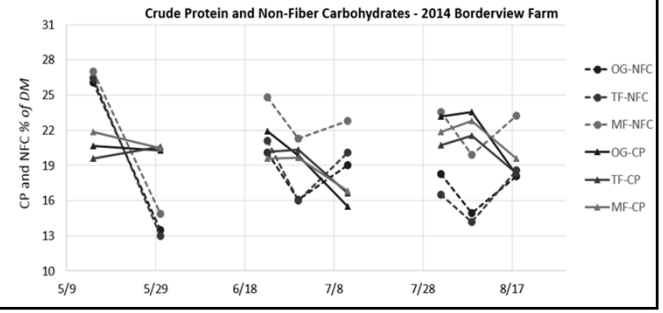
Orchardgrass, Tall Fescue and Meadow Fescue Quality



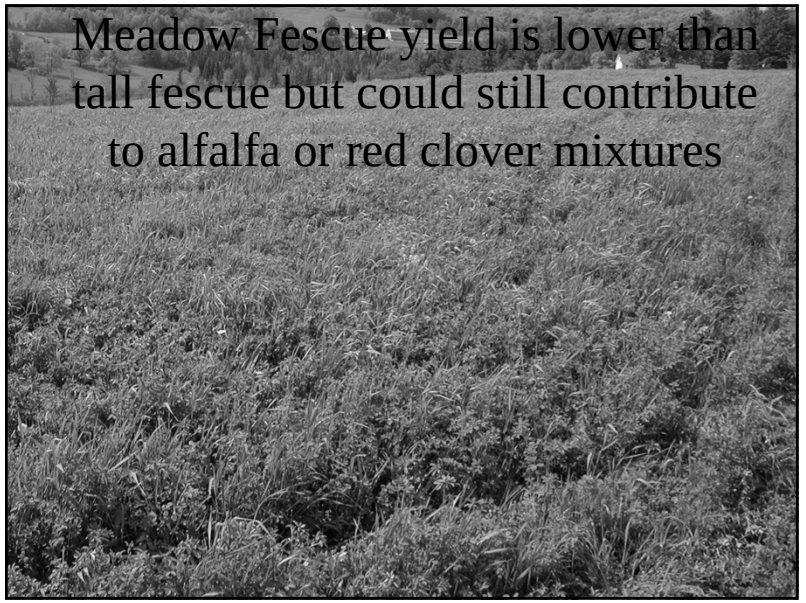
Source: Bosworth and Darby, Un. of Vermont

Orchardgrass, Tall Fescue and Meadow Fescue Quality



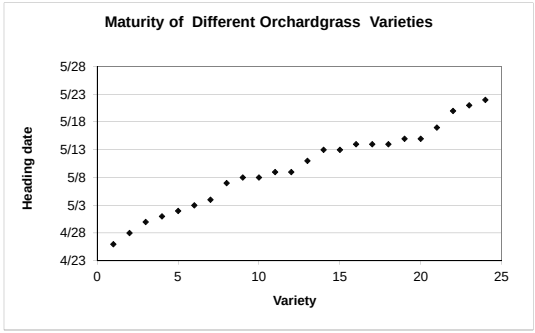


Source: Bosworth and Darby, Un. of Vermont

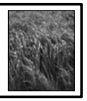


Selecting Grasses

- Match reproductive maturity (heading) to needs



Orchardgrass Maturity



- Newer late maturing cultivars (exp. Dividend VL but others)
- Sparse-heading (not on the market, yet)

Table 1 - Orchardgrass Varieties
(From the 2011 Ontario Forage Crop Variety Performance brochure - **GoForages.ca**)

Variety	Yield Index		Heading Date	Distributor
	South	North	Elora	
Early (% of Orca)[1]				
Orca	100	100	May 16	Pickseed
Rapido	102	95	May 20	Pickseed, Mapleseed
Late (% of OKAY)[2]				
Haymate	105	97	May 26	Growmark Inc.
Kay	98	98	May 30	Pride Seeds, Mapleseed
DIVIDEND VL	84	101	June 11	Quality Seeds Ltd
OKAY	100	100	June 1	Pickseed, Mapleseed

[1] Average yield of Orca in trials - southern Ontario 9.0 t/ha, northern Ontario 7.9 t/ha.
[2] Average yield of OKAY in trials - southern Ontario 8.3 t/ha, northern Ontario 7.5 t/ha.

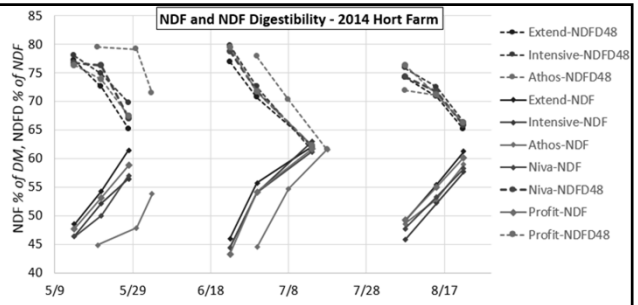
http://www.omafra.gov.on.ca/english/crops/field/forages/rethinking.htm

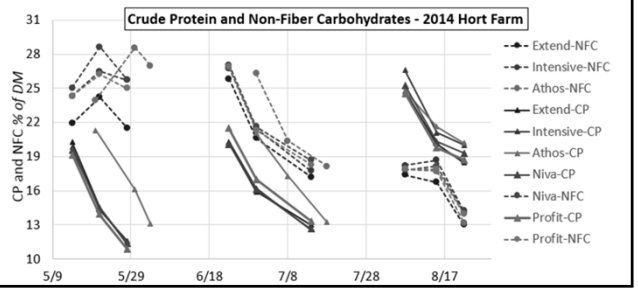
Change in Quality of Five Cultivars of Orchardgrass

South Burlington Vermont

Cultivar	Early Head*
Extend	21-May
Profit	24-May
Niva	25-May
Intensive	28-May
Athos	30-May

*Collected in 2015





Source:
Bosworth and Darby
Un. of Vermont

Temperature and Grass Development

Grass Heading Date Study - South Burlington

	n	Ave. Heading Date 1997	Ave. Heading Date 1998	Difference days
Orchardgrass	30	4-Jun	23-May	12
Timothy	44	15-Jun	11-Jun	4
Spring Conditions		Cool	Warm	

Orchardgrass development is very responsive to temperature, whereas Timothy development is more responsive to day length.

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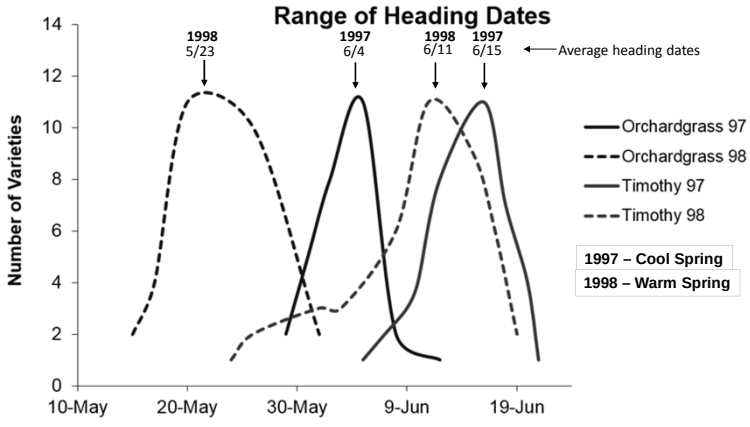
Time of Grass Seedhead Development As Influenced By Temperature and Day Length



Frequency distributions for date of heading for the same set of orchardgrass varieties (n = 30) and timothy varieties (n=44) in 1997 and 1998, South Burlington, VT

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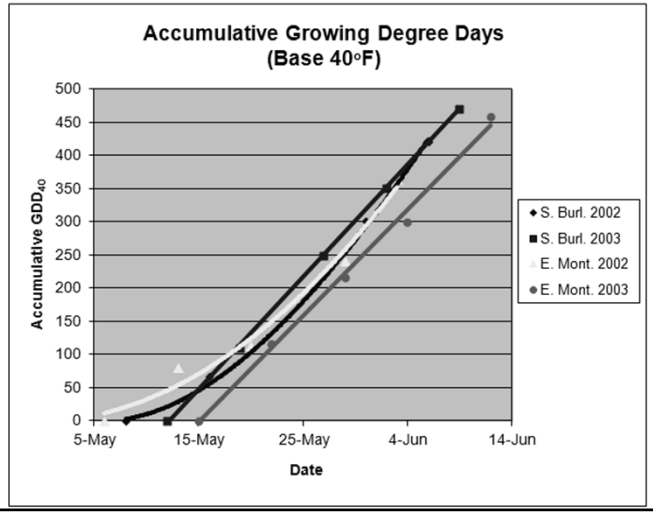
Temperature and Grass Quality



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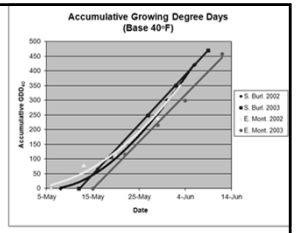
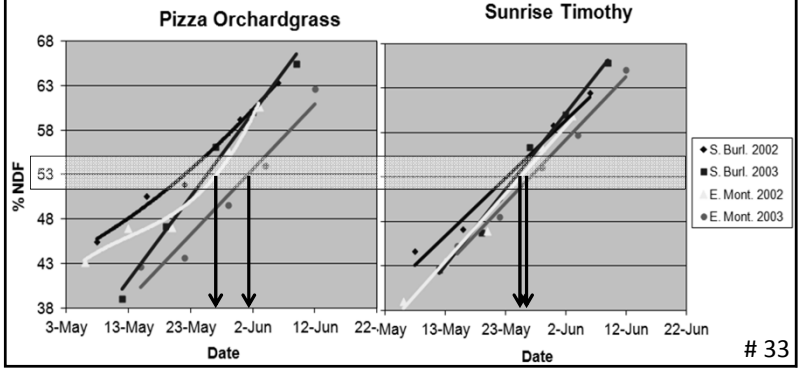
Change in NDF content of orchardgrass and timothy





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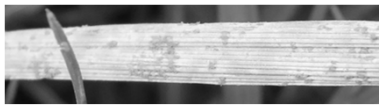
Selecting Grasses

- Rust resistant varieties (and other leaf diseases)



University of Vermont

University of Wisconsin

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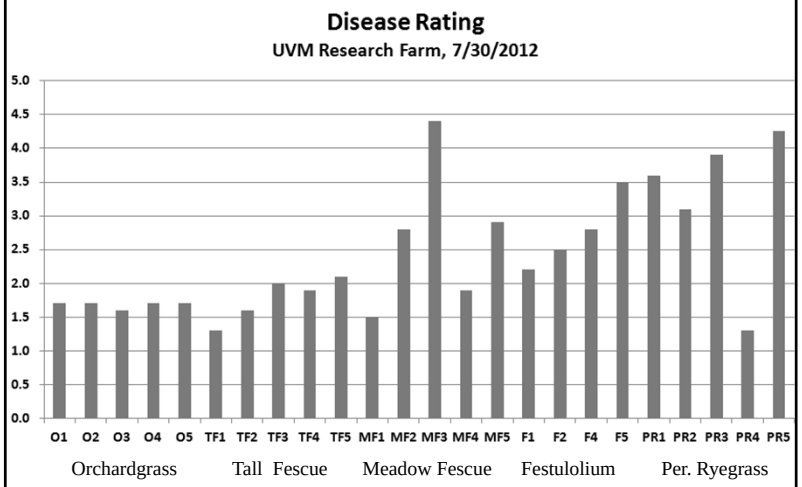
Grass Disease Ratings



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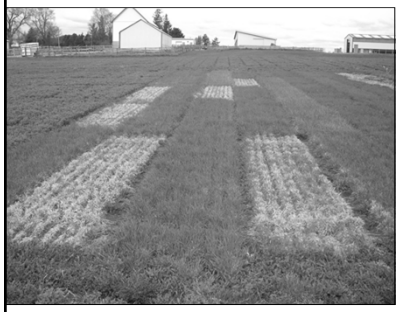
Selecting Grasses



University of Wisconsin

University of Vermont

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Perennial Ryegrass Winter Injury

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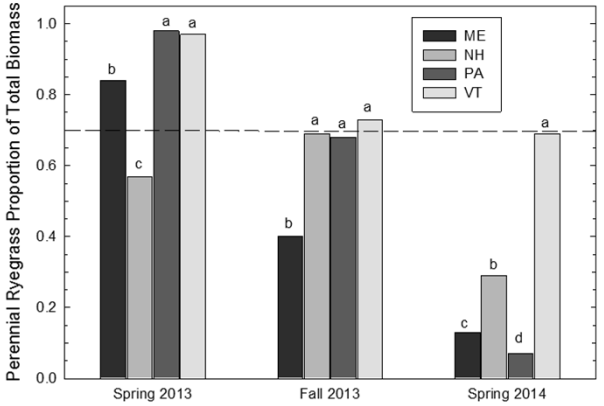
Location Effects On Perennial Ryegrass Persistence



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But … 10 cm (4 inches) of snow cover has been reported to be enough to maintain soil surface temperatures near 0 C.

Site	T min	Snow Cover	T min (<10 cm snow)
	Degree C	cm	Degree C
Maine	-28.9	60	-20.6
New Hampshire	-22.8	23-30	-15.6
Pennsylvania	-24.3	18	-22.8
Vermont	-26.1	18	-18.8

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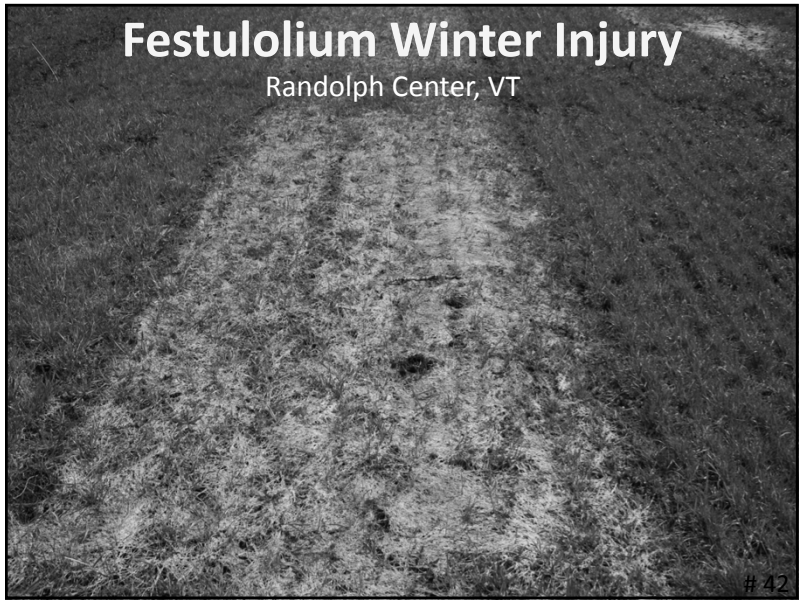
Festulolium Winter Injury



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Italian Ryegrass

- **Most rapidly establishing species**
- **Very high yields (if you treat it 'right')**
- **Disease resistance varies among varieties**
- **Plant EARLY**
- **LOVES NITROGEN**
- **Short cutting schedule**
- **High fiber digestibility**
- **Sugars/starches**

Source: Dan Hudson, UVM Extension

Italian Ryegrass

2015 Italian Ryegrass Forage Quality, Jericho, VT

Date	CP	ADF	NDF	NFC		NDFd-30	TTNDFD	RFV	RFQ
	----------% of Dry Matter ----------					-----% of NDF-----			
12-Jun	24.5	25.3	36.4	26.3	67.3	78.6	63.1	177	217.9
12-Jun	16.6	24.9	34.4	37.7	69.9	80.4	66.6	188	244.7
3-Jul	22.9	27.5	38.9	25.6	66.2	82.7	73.9	161	230.6
20-Aug	17.9	29.1	46.1	27.3	67.8	74.9	58.6	134	163.6

Source: Kirsten Workman and Dan Hudson, UVM Extension

Low Lignin Alfalfa

Does it fit in NY and VT?

Alforex Seeds Hi-Gest ALFALFA

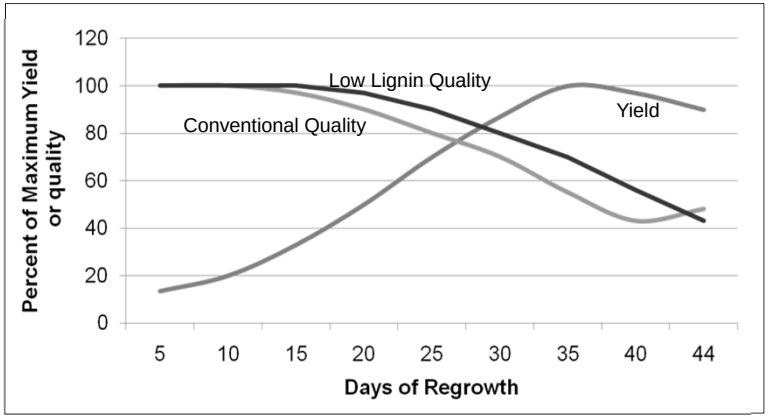
7 to 10 percent less lignin than conventional alfalfa varieties

HARVXTRA Forage Genetics International

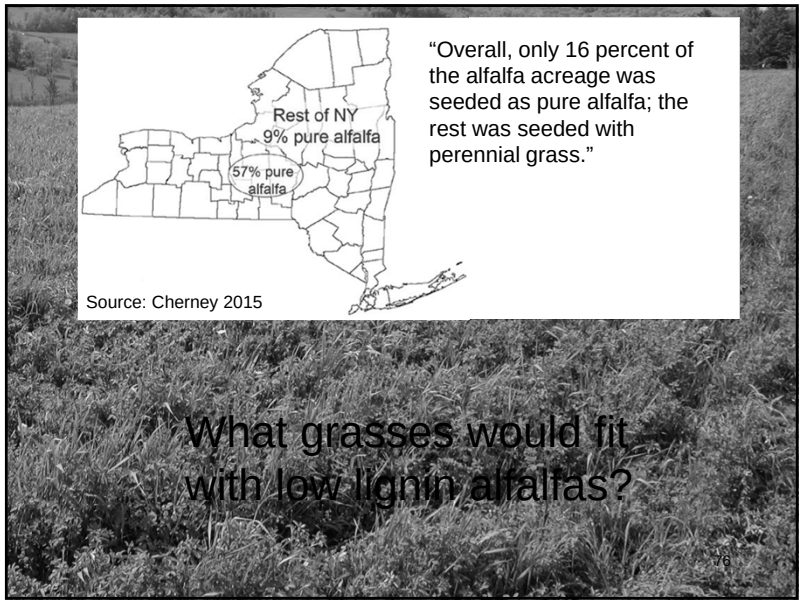
10 to 15 percent less lignin than conventional alfalfa varieties

Low Lignin Alfalfa

Does it fit in NY and VT?



Source: Dan Undersander, Un. Wisconsin



Red Clover

- Perennial forage legume
  - Forage (hay, pasture, silage)
  - Nitrogen fertility source
- Advantages
  - Easy to establish
  - Shade tolerant
  - Does well in low pH soil
  - High yielding
  - Grows well with grasses
  - Lower degradable protein
- Disadvantages
  - Less persistent (3-4 years)

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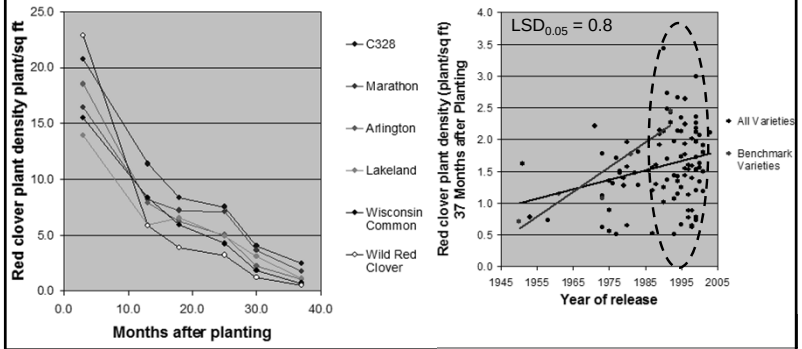
Red Clover Persistence

- Newer red clover more persistent
  - 100% red clover ground cover at 9 or more plants per sq. ft
  - Not all new red clover varieties are equally persistent



Source: Heathcliff Riday, USDA Dairy Forage Research Center

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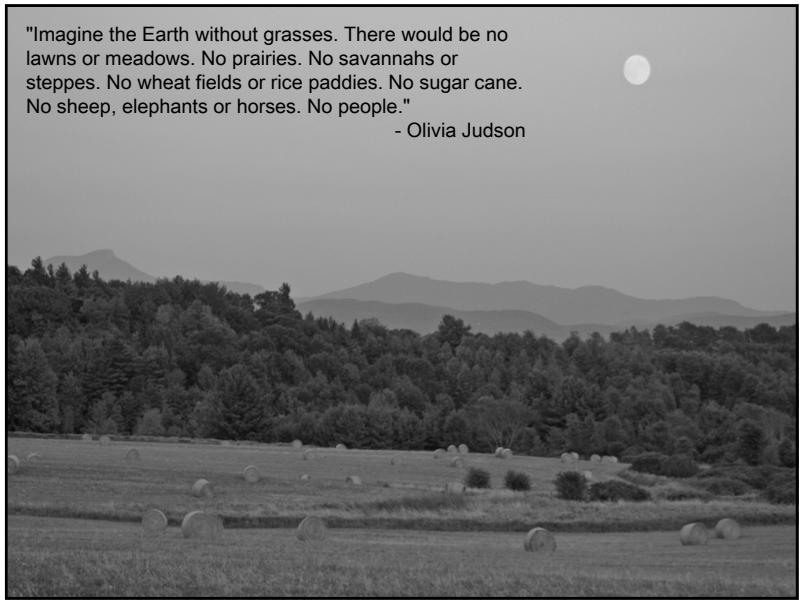
Forage Quality is the Key!


"Imagine the Earth without grasses. There would be no lawns or meadows. No prairies. No savannahs or steppes. No wheat fields or rice paddies. No sugar cane. No sheep, elephants or horses. No people."
- Olivia Judson